Effects of Animate Priming on Implicit Memory Tests

Honors Research Thesis

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by

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Abstract

Theory of Mind (TOM) has been a growing topic in the field of developmental psychology. How we recognize which objects in the world are agents and which are not is an open question. The goal of these studies was to design a priming method based on implicit memory tasks that could be used to examine participants' representations of animate agents. Undergraduates (N=173) at The Ohio State University participated in one of three studies. Participants in all three were first primed with the same video depicting a non-human, animate agent -- the Pixar Luxo Jr. Lamp short. The implicit memory task differed for each study; studies 1 and 2 presented animate-relevant and inanimate-relevant words in a lexical decision task and then later asked participants to recognize the words. Study 3 utilized a stem completion task. Statistical analysis was performed using descriptive statistics and significance testing with RMANOVA. Results for all studies indicate that we were unable to capture a priming effect. Although we were unable to design a method to successfully detect priming in this context, the methodologies used and the limitations of the studies are important contributions towards future studies looking to capture a priming effect of animacy in humans as part of the growing field of TOM.

We categorize the world into ontological kinds. Theory of Mind (TOM) is the name for the cognitive functions that operate over the ontological kind *agent*. Agents are defined as living organisms that are able to have different mental states, specifically, perceptions, attentions, desires, and beliefs. How we recognize which objects in the world are agents and which are not is an open question.

Meltzoff (1995) proposed that infants first develop their TOM around and through their earliest understanding of themselves and other people. Using an imitation procedure, he was able to show the presence of TOM in children as young as 18-months-old.

In 1998 Woodward developed an habituation procedure to test theory of mind in infants. She habituated infants with an adult who either showed or did not show a preference for a toy; the same adult then either grabbed the preferred toy or a novel toy. This method tested whether infants encode human actions in terms of the goals of the actor (reflecting an agent-world relationship), or solely in terms of the spatiotemporal movements involved. Woodward hypothesized that if infants attributed agency towards the adult, then they would dishabituate when the target reached for a novel object instead of the preferred one. Results indicate that infants as young as five months of age looked longer or dishabituated, when the hand reached for the novel toy. These results indicate that infants encode human actions in terms of the goals of the actor.

Shimizu and Johnson (2004) were interested in determining whether a non-human agent could elicit the same goal interpretation as seen in the Woodward paradigm through behavior alone with no morphological cues. To do this, they altered Woodward's method by using an oval, symmetrical green blob with no distinguishing marks anywhere on its surface instead of a human. In the agentive condition, infants received cues about both the agent and the action itself that suggested that the novel agent's approach to a target was goal directed. This was accomplished by having the green blob beep contingently when it interacted with the experimenter. Next, during the habituation trial, infants saw the green blob choose its target object by rotating itself so that its front pointed in the direction of the object it approached, which demonstrates its ability to make mindful behavioral choices. In the control condition, the green blob initially interacted randomly with the experimenter and then approached the object that it was already aligned to in the habituation trial. Johnson theorized that infants would not attribute agency to a novel object that behaved randomly and failed to make mindful goal directed behavior. As in the earlier Woodward study, the gaze data shows that infants in the agentive condition looked longer when the green blob approached the new novel toy. Infants in the control condition looked equally long during the habituation trial and the subsequent test trial. This data indicates that infants need only mindful, apparently goal directed behavioral cues to attribute agency.

Research has looked at the information infants use to determine which actions of an unfamiliar agent are goal directed. In the habituation studies by Johnson and colleagues already reviewed, infants were able to use contingent interaction and movement to infer agency. They did not infer agency if the human confederate merely modeled an intentional attribution toward the agent without the agent's active participation, or if the agent's alignment with its target was accomplished out of the infant's view. These results indicate that infants attribute non-random and internally driven behavior as goal directed.

Johnson and her colleagues (2008) used a gaze-following method to further examine these issues. By manipulating the spatial locations of the novel agent's presumed targets, Johnson was able to examine infants' ability to infer the perceiving end of a morphologically ambiguous agent with no obvious perceptual organs such as eyes, ears, or nose. In the experimental condition, infants were familiarized to the novel agent as it interacted contingently with a confederate. In the control condition, the novel agent behaved similarly, but the confederate did not respond, making the agent's behavior appear random. In both conditions, the position of the confederate was varied. For half of the infants the confederate stood on the same side of the agent as the infant (the proximal condition). For the other half of the infants, the confederate stood on the side of the agent opposite the infant (the distal condition). To test the infants' interpretation of the novel object, the agent turned quickly as though to "look" to its side. The direction of infants' own looking behavior was then measured. Results indicate that infants appear to have used the agent's behavior relative to the geometry of its physical and/or social environment to determine the agent's own geometry. In the contingent conditions, when the agent interacted with and turned toward a confederate in the proximal position, infants treated its proximal side as its front and looked themselves in the direction that the proximal end turned. In the distal contingent condition they looked in the direction that the distal end of the object turned. In the non-contingent condition infants were unable to infer anything about the orientation of the amorphous object and looked randomly in either direction.

Overall, Johnson's studies found that infants have developed a broad understanding of agents that cannot be easily reduced to humans, objects that are perceptually similar to humans, or objects that display mindless self propulsion. The goal of the current research is to develop an implicit measure of this inference that can be used in adults.

Priming can be utilized to measure implicit abilities. Priming occurs if participants show a benefit in performance on a task, given that they have recently studied related items. Spreading activation theory of semantic processing is used to explain the basic premise of priming. The theory argues that memory is an interlinked network of nodes. Each node represents a concept, and links between nodes represent relations between concepts. During the retrieval of information from memory, concepts are activated and activation spreads throughout the network (Ratcliff and McKoon 1981). In brain terms, the activation of a concept is equivalent to the electrical stimulation in neurons. The electrical signal spreads and activates nearby nodes that share closely related concepts. At each node reached in this process, an activation tag is left that specifies the starting node and the subsequent nodes activated. The effect of priming occurs when a test stimulus activates nodes that overlap with the nodes of a preceding related priming stimulus. When this happens, the previously activated pathway created by the initial priming stimulus is reactivated using the activation tag; the nodes fire faster and more efficiently (Collins, 1975). This process continues until the signal is too weak to initiate a neuronal response. The result is a cascade of neuronal activation of all interrelated concepts.

Priming activation spreads out along the neural path of conceptual networks in a decreasing gradient. The amount of activation arriving at any node is a decreasing function of the number of links the activation has traversed. Activation takes some significant amount of time to spread between nodes, 50-100 milliseconds (ms) per link (Ratcliff and McKoon, 1981).

Studies have shown that pictures are capable of producing a priming effect for words. Carr (1982) believed that words and pictures are encoded by a common amodal system. Within modality and cross modality combinations of prime and target should produce equal facilitation. Carr's results indicate that when priming is examined as a function of prime type, semantic activation accrued more rapidly from pictures than from words. This result was explained in a follow up study. He found that priming via pictures for simple naming tasks benefits more from spreading activation than does priming via words. Using pictures as a priming source results in greater spreading activation.

Experimental Design—general description

The goal of this study is to develop a method that successfully and implicitly primes participants towards animacy. In hopes of achieving this, we employed a number of implicit priming methods and tests on young adults.

According to Roediger (1992), implicit memory tests are those in which retention is indexed by transfer from previous experiences to performance on a task that, typically, seems unrelated to the previous experiences. Implicit tests can be divided into perceptual aspects of mental processing, or data driven tests, and conceptually driven tests, those that are based more on the meaning of events. We will utilize perceptual tests, tests that challenge the perceptual system by presenting information in a degraded form, either fragmented items or items shown very rapidly (e.g., stem completion, word fragment completion, lexical decision tasks, or picture fragment identification). All implicit tests direct subjects to solve the given problem as well as possible, no other instructions.

We developed a three-stage method. The first two stages constitute a cross modal priming phase. Subjects in the priming condition watch a movie that demonstrates obvious animacy while control subjects watched no movie. We believe that a video will prime subjects similarly to the priming effect of pictures. Priming using pictures facilitates perceptual priming.

Because Johnson's (2003) prior studies showed that infants are able to attribute animacy based on behavioral cues alone, we chose to prime participants with a video that demonstrates animacy without any human morphological cues, the Pixar Luxo Jr. Lamp short. This film shows an interaction between a large lamp and a small lamp. Although there are no words and no morphological cues, all humans regardless of age are able to understand that the lamps are animate agents. Our ability to understand this abstract interaction demonstrates that humans are utilizing their TOM. We believe that this video will prime participants towards animacy. By using a video we hope to target perceptual implicit abilities.

The second stage of the experiment will consist of a lexical decision task. The procedure for a lexical decision task involves measuring subjects' ability to classify stimuli as words or non-words. Perea (1997) was able to show that a priming effect can occur during a lexical decision task for words via spreading activation. The Study 1 lexical decision task will be comprised of animate and inanimate scrambled words as well as animate and inanimate non-scrambled words, while Study 2 will be comprised of animate and inanimate words and nonsense words. The lexical decision task will semantically prime participants towards the words presented. Lexical decisions scores (subjects' ability to correctly identify stimuli) were recorded for analysis. Both the Luxo Jr. video and lexical decision task comprise the two-stage priming phase of our method.

We believe that a compounding priming effect will occur for animate words for subjects who have been initially primed towards animacy by watching the Luxo Jr. lamp video. Subjects who previously watched the Luxo Jr. video will already have spreading activation occurring within their brain. As a result, when they complete the lexical decision task, animate words will further strengthen the spreading activation, which in turn will strengthen the priming effect. As stated previously, pictures can prime semantic relationships.

Stage three of the experiment will consist of a recognition task, which is an explicit memory test. Participants in Study 1 were asked to recognize as many words as possible from a list that consisted of all the words from the lexical decision task including the scrambled words, which were now being presented in their non-scrambled form. In Study 2, subjects completed a recognition task comprised of words they had previously seen on the lexical decision task as well as novel words they had never seen.

Although one priming step may be sufficient, we chose to utilize two steps, the Luxo Jr. lamp video and the lexical decision task, because of the abstract nature of TOM. As an implicit function, it is very difficult to design studies that capture a TOM affect. We chose to design as powerful a method as possible in order to demonstrate an unforced interpretation of the Luxo Jr. video and indicate the presence of a TOM. If successful, further studies would be completed to explore whether one priming step is sufficient to elicit a TOM response.

After the recognition test subjects were asked to complete a Baren Cohen's Autism Quotient (AQ) survey. The AQ survey consists of fifty multiple-choice questions. It aims to investigate whether adults of average intelligence have symptoms of autism. (Baron-Cohen, 2001). Measuring subjects' AQ score will allow us to determine if different ranges on the autism spectrum effect animate priming and thus subjects' recognition task scores. Sex was also recorded to determine whether there were any differences between males and females performance on the recognition task.

Table 1.

<table>
<tr><th>Study</th><th colspan="4">Independent Variable</th><th colspan="4">Dependent Variable</th><th>Hypothesis</th><th>Results</th></tr>
<tr><td rowspan="5">1</td><td colspan="4">Condition</td><td colspan="4">Recognition task</td><td rowspan="5">subjects who are primed towards animacy will recognize more animate words than inanimate words during the implicit memory test (recognition test) than control subjects who were not primed towards animacy</td><td rowspan="5">significant main effect of condition, F(1,43)=6.457, p=0.015; significant interaction of word type by condition, F(1,43)=6.565, p=0.01; no significant interaction of animacy by word type by condition F(1,43)=2.023, p=0.162</td></tr>
<tr><td colspan="2">Luxo Jr.</td><td colspan="2">Control</td><td colspan="2">unscrambled form</td><td colspan="2">non-scrambled words</td></tr>
<tr><td colspan="4">Lexical Decision task</td><td rowspan="3">15 Animate</td><td rowspan="3">15 Inanimate</td><td rowspan="3">15 Animate</td><td rowspan="3">15 Inanimate</td></tr>
<tr><td colspan="2">scrambled words</td><td colspan="2">non-scrambled words</td></tr>
<tr><td>15 Animate</td><td>15 Inanimate</td><td>15 Animate</td><td>15 Inanimate</td></tr>
<tr><td rowspan="5">2</td><td colspan="4">Condition</td><td colspan="4">Recognition task</td><td rowspan="5">subjects primed towards animacy will recognize more of the previously seen animate words and (wrongly) recognize more animate words that are novel, than control subjects not primed towards animacy</td><td rowspan="5">no significant main effect of condition, F(1,36)=0.354, p=0.556; no significant interaction of animacy by novelty by condition F(1,36)=2.294, p=0.139</td></tr>
<tr><td colspan="2">Luxo Jr.</td><td colspan="2">Control</td><td colspan="2">words seen on lexical decision task</td><td colspan="2">novel words</td></tr>
<tr><td colspan="4">Lexical Decision task</td><td rowspan="3">10 Animate</td><td rowspan="3">10 Inanimate</td><td rowspan="3">10 Animate</td><td rowspan="3">10 Inanimate</td></tr>
<tr><td colspan="2" rowspan="2">20 Nonsense</td><td colspan="2">words</td></tr>
<tr><td>20 Animate</td><td>20 Inanimate</td></tr>
</table>

STUDY 1

Hypothesis: subjects who are primed towards animacy will recognize more animate words than inanimate words during the implicit memory test (recognition test) than control subjects who were not primed towards animacy.

Method

Participants. Fifty introductory psychology students at The Ohio State University participated in either a priming (N_{total}=25, N_{male}=14, N_{female}=11) or control (N_{total}=25, N_{male}=16, N_{female}=9) condition.

Tasks.

Lexical Decision Task. A set of sixty English words was compiled: fifteen animate, fifteen inanimate, fifteen scrambled animate and fifteen scrambled inanimate. Words were scrambled to insure that subjects were paying attention during the lexical decision task. Animate words were chosen by the following criteria: an animate state of being, agents, senses and cognitive functions. Animate words were chosen that could only explicitly apply to animate entities (i.e., goal is not animate because one can have a goal to achieve something or a soccer goal). The word length ranged from 3 to 8 letters. There were two versions of the lexical decision task. Each was randomized and pseudo-randomized so that there were no more than two words of the same word category (animate or inanimate) next to each other. See list of words in Appendix A.

Recognition task. All sixty words, both scrambled and non-scrambled, from the lexical decision task were shown. The scrambled words were shown in their non-scrambled form. See Appendix B for full list of words.

Autism Quotient. This is a self-report scale designed to assess subjects' relative sensitivity to social information.

Procedure.

Priming condition. Subjects were tested one at a time. Each subject would first watch the Pixar Luxo Jr. lamp short. Following this, subjects would engage in a lexical decision task comprised of sixty items presented one at a time in the center of a computer screen. Subjects were required to state aloud whether the arrangement of letters was an English word. For each item, subjects were able to control the item trial speed using the computer's mouse. After completing the lexical decision task, participants were given a recognition task. For this task, the 60 items were presented on paper and subjects were told to circle as many words as they recognized from the lexical decision task. There was no time limit.

Control condition. This condition was identical to the priming condition with the exception that the subjects began the experiment with the lexical decision task. Subjects saw no initial video.

After completion of the experimental tasks, all subjects completed the AQ.

Results

Preliminary analysis showed no effect of sex ($F(1,43)=1.147$, p=0.290), lexical decision task score ($F(1,43)=0.054$, p=0.817), and Autism Quotient (AQ) ($F(1,43)=0.576$, p=0.452) so they were excluded as covariates from analysis. Two subjects scoring less than 80% correct on lexical decision task were excluded from analysis.

The items “goal” and “prefer” were excluded from analysis due to ambiguity towards animacy and experimenter errors on making recognition sheets, respectively.

To measure the effect, the mean scores for animate scrambled, animate non-scrambled, inanimate scrambled and inanimate non-scrambled were calculated (See Figure 2). Next we analyzed the means by running a 2 x 2 x 2 Repeated Measure Analysis of Variance (RMANOVA). The between subjects factor was condition (Luxo Jr. vs. control). Within subject factors were word category (animate vs. inanimate) and word type (non-scrambled vs. scrambled.

Between subjects analysis indicate that there is a significant main effect of condition ($F(1,43)=6.537$, p=0.014, $M_{Luxo\ Jr.}=0.776$, $M_{control=}0.435$). The total number of words recognized, both animate and inanimate, was significantly more in the Luxo Jr. condition than in the control condition, as illustrated in Figure 1.

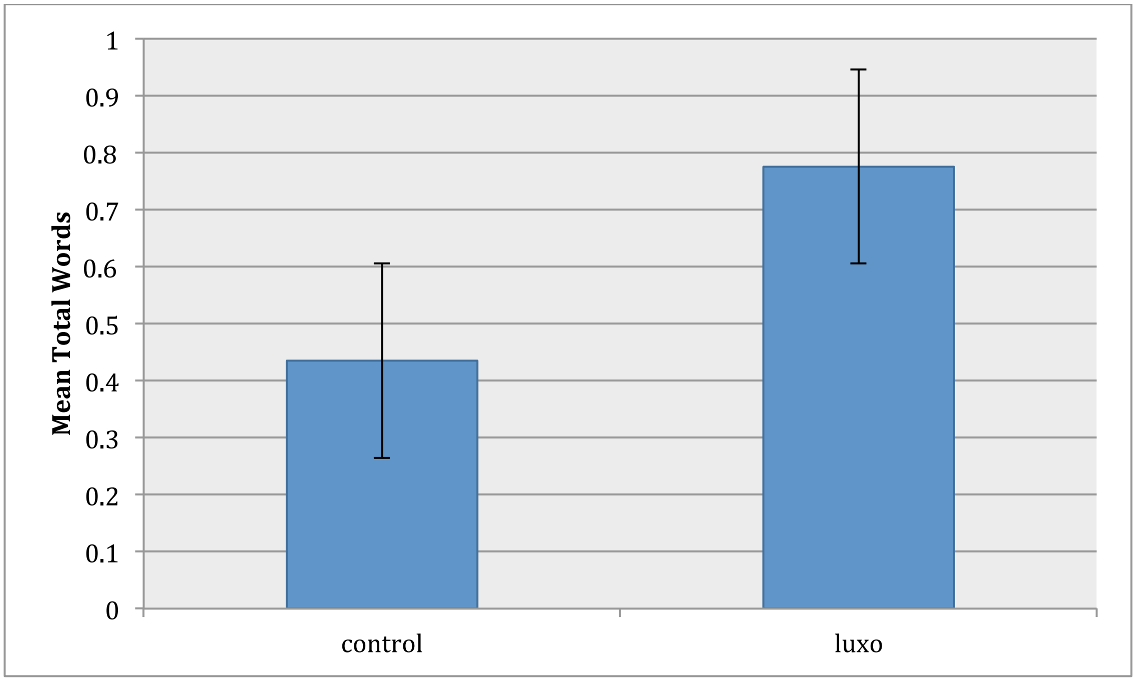

Figure 1.

Within subjects analysis indicates that there is a significant interaction of word type by condition ($F(1,43)=6.455$, $p=0.015$). Specifically, the amount of scrambled words recognized between conditions was the same, while the Luxo Jr. condition ($M_{Luxo\ Jr.}=0.651$) recognized significantly more non-scrambled words than the control condition ($M_{control}=0.518$). There was no significant interaction of animacy by word type by condition ($F(1,43)=2.291$, $p=0.137$), as illustrated in Figure 2.

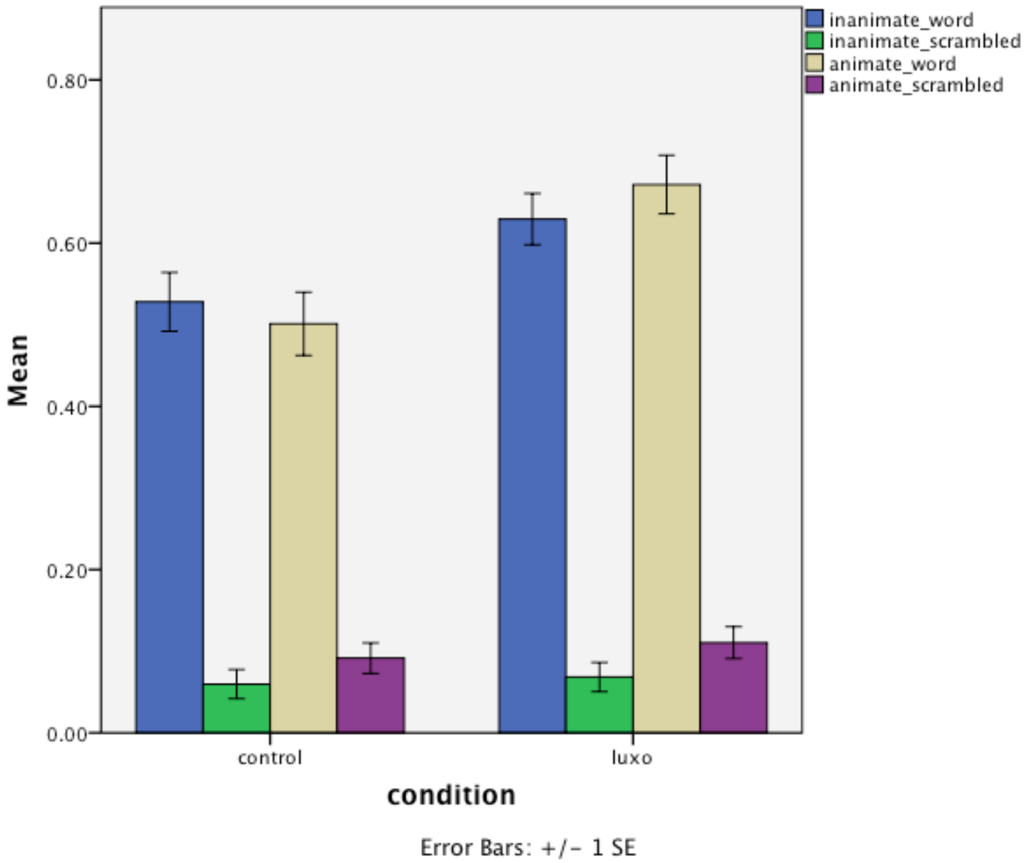

Figure 2.

A post hoc paired sample t-test of animate versus inanimate words within condition was done to explore whether subjects recognized more animate than inanimate words when primed towards animacy. Analysis shows that there is a trend towards a significant effect in the Luxo Jr. condition, ($t(24)$=-1.776, p=0.088, $M_{animate.}=0.672$, $M_{inanimate.}$=0.629) and no significant effect in the control condition ($t(22)$=0.605, p=0.551, $M_{animate}$=0.507, $M_{inanimate.}$=0.530). Subjects in the Luxo Jr. condition remembered almost significantly more animate words than inanimate words, as illustrated in Figure 2.

Discussion

The null effects of the interaction of animacy by word type by condition does not support our initial hypothesis that subjects in the priming Luxo Jr. condition will recognize significantly more animate words than subjects in the control condition. Although we were able to find a trend towards significance in the animate versus inanimate words recognized within conditions, as a post hoc test and a non-significant effect, we are unable to draw any conclusions from it.

A major limitation of this study was the ease of the lexical decision task. Subjects were at ceiling for the lexical decision task, which indicates the task was not difficult enough to detect any potential advantage provided by the video prime.

STUDY 2

Background

Multiple revisions were made to the method for Study 2. To insure that the lexical decision task was hard enough, subjects would no longer be allowed to control the speed of individual items on the lexical decision task. Each test item on the lexical decision task appeared for 150 ms followed by a 1 second (s) masking screen (#####) followed by a blank white screen. At this point, subjects were asked to complete the lexical decision task for the test item. Subjects could only control when to continue to the next item.

In order to capture the priming effect, we included a second measure in the study. We believe that subjects who were primed towards animacy in the Luxo Jr. condition would falsely recognize more novel animate words during the recognition task than subjects in the control condition. To test this we altered both the lexical decision task and the recognition task. During the lexical decision task subjects will see twenty animate words, twenty inanimate words, and twenty nonsense words. During the recognition task, subjects will be given a total of forty words, twenty animate and twenty inanimate. The two groups of animate and inanimate words are each comprised of ten words they had previously seen on the lexical decision task (old) and ten novel words (new).

Hypothesis: subjects primed towards animacy will recognize more of the previously seen animate words and (wrongly) recognize more animate words that are novel, than control subjects not primed towards animacy.

Method

Participants. Forty-three introductory psychology students at The Ohio State University participated in either a priming (N_{total}=22, N_{male}=6, N_{female}=16) or control (N_{total}=21, N_{male}=12, N_{female}=9) condition

Tasks.

Lexical Decision Task. A set of sixty lexical items was compiled: twenty animate, twenty inanimate, and twenty nonsense words. The animate and inanimate words were pulled from the word list used in study 1. Nonsense words were created to match word length (3-11 letters) and semantic English requirements. Test items would appear on the screen for 150 ms followed by a masking screen (####) for one second and then a white slide. At this point participants would verbally complete the lexical decision task. Subjects would then use the mouse to proceed to the next task. See Appendix C for full list of words.

Recognition task. Forty words were used to create the recognition task: twenty animate and twenty inanimate. The two groups of animate and inanimate words are comprised of ten words they had previously seen on the lexical decision task (old) and ten novel words (new). See Appendix D for full list of words.

Autism quotient. The AQ was the same as in study 1.

Procedure. The Priming and control conditions were identical to the priming and control conditions in Study 1.

Results

Preliminary analysis showed no effect of sex ($F(1,36)=0.114$, $p=0.738$), lexical decision task score ($F(1,36)=0.391$, $p=0.536$), and Autism Quotient (AQ) ($F(1,36)=0.046$, $p=0.831$), so they were excluded as covariates in analysis. Two subjects scoring less than 80% correct on the lexical decision task were excluded from analysis.

To measure the effect, we scored and calculated the means for animate “old” and “ new” words and inanimate “old” and “new” words (Figure 4). Next we analyzed the means by running a between within subject 2 x 2 x 2 RMANOVA. The between subjects factor was condition (Luxo Jr. vs. control). Within subject factors were word category (animate vs. inanimate) and novelty (old vs. new).

The between subjects main effect of condition seen in study one has completely disappeared ($F(1,39)=0.441$, $p=0.511$, $M_{Luxo\ Jr.}=0.855$, $M_{control}=0.922$), illustrated by Figure 3. Subjects in both conditions are now recognizing equal amounts of both animate and inanimate words, both new and old.

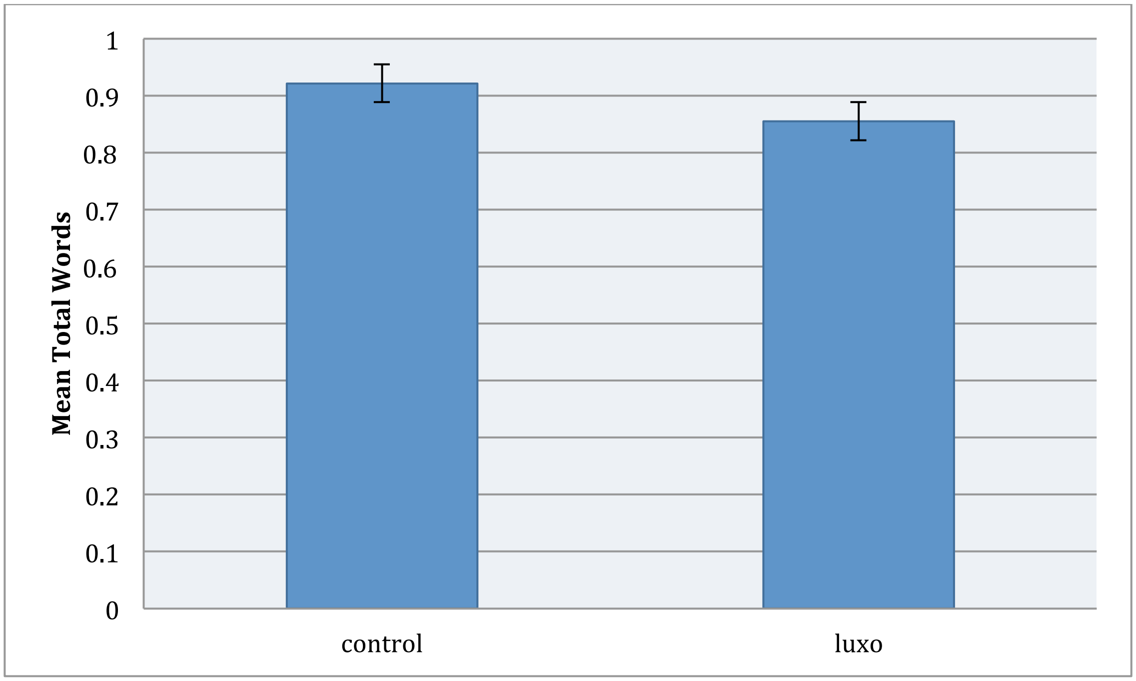

Figure 3.

Within subjects analysis indicates that there is a trend towards a significant interaction of animacy by novelty by condition ($F(1,39)=3.888$, $p=0.056$) as illustrated in figure 4. Subjects in the control condition are recognizing more inanimate old words than animate old words.

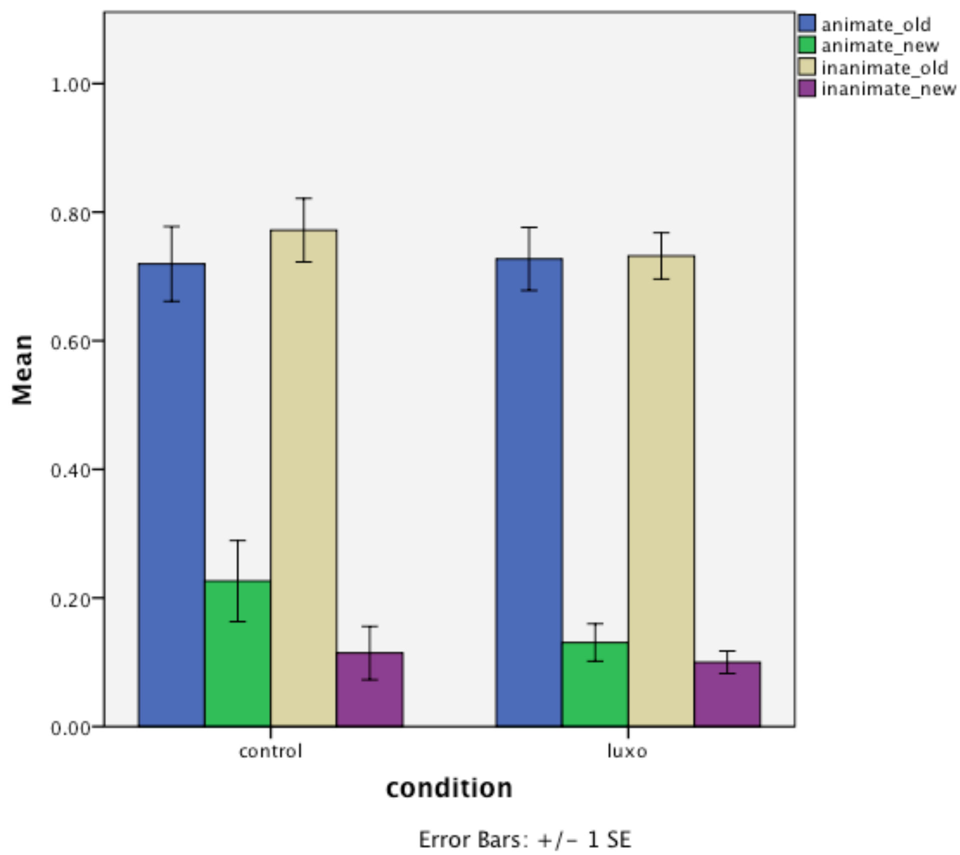

Figure 4.

A post hoc paired sample t-test of animate old versus inanimate old words and of animate new versus inanimate new words within condition was done. There was no significant effect for animate old versus inanimate old ($t_{control}(20)$=-1.171, p= 0.255, $t(19)$=0.463, p=0.349) within conditions. There was a significant effect of animate new versus inanimate new within conditions ($t_{\text{control}}(20)$=3.686, p=0.001, $t_{luxo}(19)$=1.250, p=0.226) as illustrated by figure 4.

Discussion

Study 2 does not support our hypothesis. These results are unexpected and cannot be explained within the revisions made to Study 2. However, there are theoretical limitations of the study that may explain our inability to capture the priming effect.

General Discussion of Studies 1 and 2

There is no doubt that the Luxo Jr. Pixar lamp short is successfully priming participants towards animacy. I believe that the reason we are unable to capture the priming effect is because of unintended priming effects.

The Luxo Jr. video is comprised of basic physical objects that include lamps, lights, and a ball. Although the behavior is understood as being animate, the sheer amount of physical inanimate objects in the video likely partially primed subjects towards inanimacy.

The morphological shape of words is responsible for some priming effects in the Lexical Decision Task. Morton (1969) developed the logogen model which shows that a given letter stimulus will induce activate in all words that resemble the stimulus to any degree, the amount of activation being proportional to the degree of morphological overlap between the stimulus and the word.

In conjunction with each other, the physical inanimate objects in the priming video and the theories of morphological priming may account for the results from Study 1. Specifically, the between subjects main effect of condition and null effect of animacy by word type by condition can be explained. If we consider that the subjects were primed towards animacy and inanimacy after seeing the priming video, during the lexical decision task subjects will be primed towards all words equally either by their morphology, or by their categorization of animate or inanimate words. Because the Luxo Jr. video is predominantly animate one would expect that subjects would be marginally primed towards animacy stronger than towards inanimacy, as seen by the results of the paired samples t-test in Study 1.

It should also be noted that another limitation of these two studies was not looking at the effects of word length. Forster and Davis (1987) found that the length of the target was a powerful determinant of the size of the priming effect with implicit primes. Words of five letters or more were capable of producing a strong priming effect while words of four letters or less produced a much weaker priming effect. Designing the study in a way as to analyze recognition by word length (short vs. long) may reveal significant information about how animacy is implicitly primed.

STUDY 3—Exploratory

Table 2.

Study	*Independent Variable*		*Dependent Variable*	*Hypothesis*	*Results*
	Condition		Stem Completion task		
3	Luxo Jr.	Rube Goldberg	Animate Words used	Subjects in the Luxo Jr. condition will use significantly more animate words to complete the stem completion task than subjects in the Rube Goldberg condition	no significant main effect of condition, F(1,80)=1.120, p=0.293

Background

In a final effort to capture the priming effect, the lexical decision task and recognition task were omitted for Study 3 and replaced with a stem completion task. Graf and Mandler (1984) developed what is now considered to be the classic stem completion test. During this test, subjects are given the first three letters of words and told to complete the words. Each stem has ten or more possible completions. All of the stems are created to be easy so that subjects can complete all of them relatively quickly. The quick responses insure that the test measures implicit function. Stem completion tests have been shown to be effective for capturing priming effects. Removing the lexical decision task will hopefully allow us to capture a purely animate priming effect.

Another benefit of this design is that by removing the lexical decision task we are also eliminating extra time between the priming video and the implicit memory task. In doing so, we can insure that we are capturing the priming effect before it temporally dissipates.

In case seeing a video has some effect on subjects, we are now including a Rube-Goldberg machine video in the control condition. A Rube Goldberg machine is a deliberately over-engineered or overdone machine that performs a very simple task in a very complicated fashion, usually including a chain reaction. The video of the Rube-

Goldberg machine demonstrates purely physical motions and should demonstrate no meaningful information about animacy for subjects. That is, subjects will watch a video that primes nothing.

Hypothesis: subjects who are primed towards animacy will use more animate words to complete the stem completion task than subjects who are not.

Method

Participants. One hundred and fourteen introductory psychology students at The Ohio State University participated in either a priming (N_{total}=36, N_{male}=19, N_{female}=17) or control (N_{total}=44, N_{male}=26, N_{female}=18) conditions.

Tasks

Stem Completion Task. The list of sixty words, animate and inanimate, from Study 1 was used to create sixty stems. The sixty stems were divided into three groups/clusters of twenty. The twenty words were comprised of ten animate and ten inanimate words. Each group of twenty was individually randomized and pseudo-randomized: there were no more than two stems in a row that began with the same letter. Moreover, each group of 20 words was matched so that there was no more than 1 standard deviation of word length between clusters ($M_{cluster\ 1}$=5.65, $M_{\text{cluster }2}$=5.65, $M_{\text{cluster 3}}$=5). There were four versions of the stem completion task. Each participant saw all sixty stems. See Appendix E for list of stems.

Procedure

Priming condition. Subjects were tested in groups. They sat around a large table with an iMac in the middle where they would all watch the priming Pixar Luxo Jr. Lamp video. After the video subjects would be given the stem completion task and asked to complete as many stems as possible. There was no time limit.

Control condition. This condition was identical to the priming condition with the exception that the subjects began the experiment by watching the Rube-Goldberg machine video.

Coding

Coding Criteria: agents, verbs that can only be attributed animate entities, state of being that can only be attributed to animate entities, ambiguous words (those that can either be animate or inanimate depending on context were coded as inanimate), anatomy was considered inanimate, and microbiological terms (e.g., cell) were considered inanimate.

Results

All data for cluster 1 was omitted from analysis due to experimenter error. Subjects receiving version 2 of the stem completion task received a list with an incorrect cluster 1. They saw different items than the rest of the subjects for that cluster. Preliminary analysis showed effect of sex so it was included as a variable in analysis.

Preliminary analysis showed no effect of sex ($F(1,80)=0.3.829$, $p=0.054$), and no effect of stem completion task version ($F(1,80)=0.049$, $p=825$) so they were excluded as covariates in analysis.

The mean number of animate words used to complete the stems was calculated per condition (Figure 5). The means were analyzed using a between within subjects 2 x 2 x 2 RMANOVA. The between subject factor was condition. Within subjects factors were cluster (2 vs. 3) vs. Item (20 stems in cluster 2 vs. 20 stems in cluster 3). Results indicate no significant main effect of condition ($F(1,82)=1.452$, $p=0.232$, $M_{control}=0.270$, $M_{Luxo\ Jr.}=0.280$), illustrated in Figure 5.

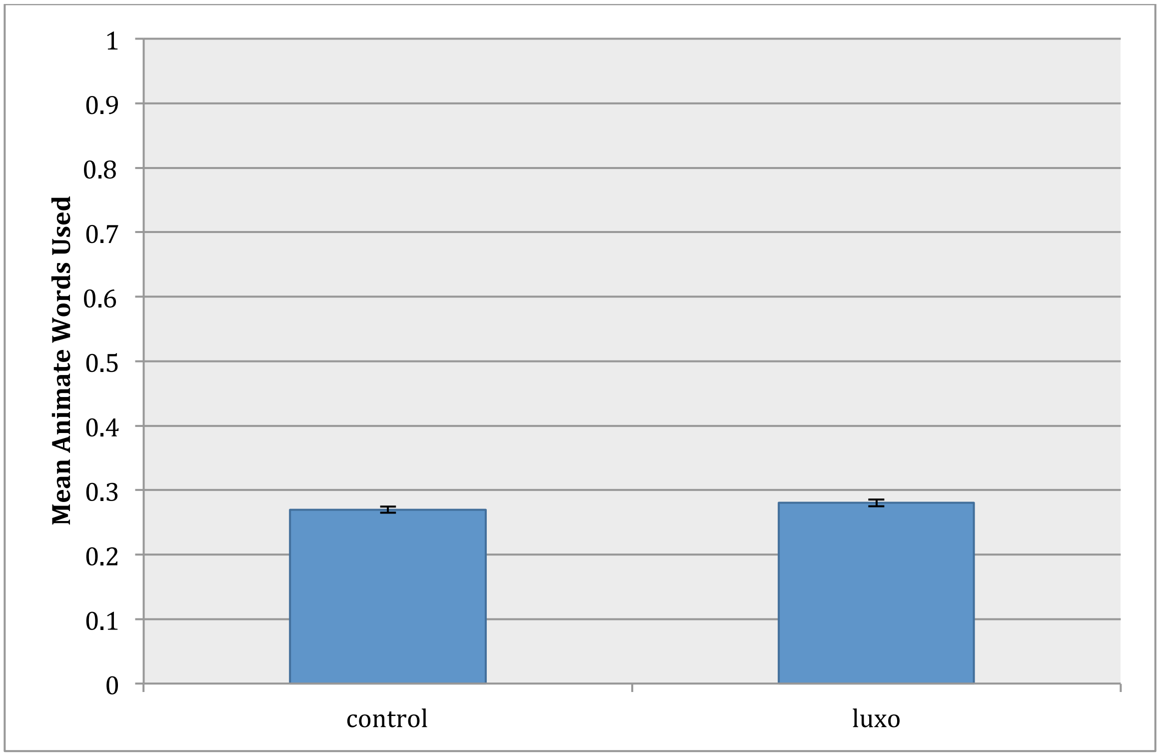

Figure 5.

Discussion

The results of Study 3 do not support our hypothesis, that subjects in the Luxo Jr. video would use significantly more animate words to complete the stem completion task. I believe the reason we did not capture the priming effect is because the task was too open ended. Priming effects are generally difficult to capture. By giving subjects such free range in their responses, the experimental design made it very difficult to pick up such a small effect. Later studies should use a more structured stem completion/word completion task. For instance, subjects can be given an arrangement of letters with one or two letters missing. These items should be designed so that subjects are limited in how they can complete the words in such a manner that they can either make it an animate word or an inanimate word. For example, ho_e can either be completed to form the word hope, an animate word, or hole, an inanimate word. By limiting subjects' responses, experimenters should be able to capture very small priming effects.

Another possible area of concern for Study 3 is the actual methodology. Unlike Studies 1 and 2, the implicit test in Study 3 does not resemble the priming step. As a result, we are now targeting conceptual implicit memory compared to perceptual implicit memory. Conceptual tests focus on the generation of words from an associate or from a category or name by answering a general knowledge question. There is no visual similarity between the test format and the study format for conceptual tests. The connection between the study and test is based on the overarching conceptual meaning of the study (Roediger, 1992). In theory, because we are trying to prime participants towards a cognitive concept, animacy, it would make sense for the priming effect to show up in a conceptual memory test. However, this may not be the case. Animacy may be limited to either perceptual or conceptual memory. If so, changing which implicit memory we target, from perceptual to conceptual, may explain why we were unable to capture the priming effect in this study.

Conclusion

Being a social species necessitates that we, as individuals, are able to understand that other people have different mental states, specifically, perceptions, attention, desires, and beliefs. Therefore, how exactly we are able to do this is of particular theoretical importance. Historically, most work in this area has focused on detecting the presence of a Theory of Mind. However, the question looking at how we are able to apply it is still unsolved. How humans are able to make sense of the world, specifically agents, is complex and is surely comprised of many different mechanisms.

Although we were unable to capture the animate priming effect of the Luxo Jr.

video, the above studies have revealed new information that will contribute towards developing a method that successfully captures an animate priming effect. Successfully developing a method that captures an implicit priming effect of animacy with a blatant animate prime will allow researchers to test more abstract demonstrations of animacy. Researchers will be able to explore and understand the implicit mechanisms to which humans attribute animacy and Theory of Mind.

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Appendix A

air, angry, birth, breathe, bug, cell, cisk, creature, debel, die, disel, doubt, eret, fall, feel, ferrep, force, gnith, goal, grem, grow, guess, heal, heat, human, kown, leaf, light, lod, malc, mells, netlap, nocae, ogd, olok, orbit, pedal, perspire, phyap, plose, pohe, push, rahe, ribus, sad, sart, scivored, smash, snufug, speed, stem, tericcle, thear, tih, tonse, turif, udb, vibrate, want, wobble

Appendix B

- Animate non-scrambled: angry, birth, breathe, bug, creature, die, doubt, feel, goal, guess, heal, human, perspire, sad, want
- Inanimate non-scrambled: Air, cell, fall, force, grow, heat, leaf, light, orbit, petal, push, smash, speed, stem, vibrate
- Animate scrambled: bleed, bowel, calm, discover, dog, germ, happy, hear, hope, know, look, sick, smell, virus, prefer
- Inanimate scrambled: bud, earth, electric, fruit, fungus, hit, night, ocean, old, planet, slide, slope, star, stone, tree

Appendix C

- Animate: angry, calm, discover, disgust, doubt, embarrassment, excited, fear, feel, goal, guess, happy, hope, memory, recognize, sad, shame, smell, want, wish
- Inanimate: atmosphere, collide, electric, force, gravel, heat, leaf, magnify, night, old, petal, planet, cell, seed, slope, smash, seed, stem, tree, vibrate
- Nonsense: brare, cowarms, cribe, danving, dicell, eliminal, fixtuate, fusent, giviews, gub, lige, mapply, mezz, phents, siz, stants, usp, weem, whir, zung

Appendix D

- Animate old: angry, discover, doubt, excited, fear, goal, memory, recognize, sad, smell
- Inanimate old: electric, force, leaf, magnify, night, old, petal, planet, tree, vibrate
- Animate new: confuse, curious, hear, inspire, know, refer, see, seek, surprise, taste
- Inanimate new: environment, fall, fruit, light, ocean, orbit, push, slide, star, stone

Appendix E

- Cluster 1: co_______, sh_______, ha_______, fe_______, wa_______, ta_______, an_______, kn_______, em_______, go_______, pu_______, ni_______, gr_______, le_______, st_______, at_______, ma_______, sl_______, or_______, vi_______
- Cluster 2: re_______, sm_______, sa_______, fe_______, gu_______, ho_______, ex_______, do_______, re_______, di_______, fa_______, en_______, st_______, el_______, fr_______, sp_______, li_______, tr_______, st_______, co_______
- Cluster 3: me_______, ca_______, se_______, in_______, se_______, su_______, cu_______, di_______, he_______, wi_______, se_______, ol_______, sm_______, ce_______, sl_______, pl_______, pe_______, he_______, fo_______, oc_______